WAR DEPARTMENT,
SURGEON GENERAL'S OFFICE,
JULY 6, 1870.

REPORT TO THE SURGEON GENERAL,

OF THE

UNITED STATES ARMY,

ON CERTAIN POINTS CONNECTED WITH THE

HISTOLOGY OF MINUTE BLOODVESSELS.

By Brevet Lieutenant Colonel J. J. WOODWARD,
ASSISTANT SURGEON, U. S. ARMY.

WASHINGTON, D. C., 1870.

REPORT

ON CERTAIN POINTS CONNECTED WITH THE

HISTOLOGY OF MINUTE BLOODVESSELS.

ARMY MEDICAL MUSEUM,
MICROSCOPICAL SECTION,
July 6, 1870.

BREVET MAJOR GENERAL J. K. BARNES,
SURGEON GENERAL, U. S. ARMY.

GENERAL: Having recently been occupied in the critical examination of certain preparations, in the Microscopical Section of the Museum, illustrative of the minute anatomy of the bloodvessels, I have thought that some of them threw so much light on certain points involved in the recent discussions with regard to the doctrine of inflammation, that a short account of them would be of interest, and might perhaps do good service, in connection with the appreciation of the conflicting statements which have appeared in the Medical Journals since the publication of the paper of Dr. J. Cohnheim,* on inflammation and suppuration.

Perhaps the observations of Cohnheim must fairly be regarded as elaborations of the previous experiments of Dr. Augustus Waller, but certainly they produced an impression upon the medical world far beyond that made by the papers in the Philosophical Magazine,† and more or less complete accounts of the conclusions arrived at by the distinguished Berlin observer have continued to appear, from time to time, in both foreign and American Medical Journals, ever since the publication of his paper in 1867.

Recently protests against these conclusions have appeared in various quarters, among which particular reference may be made to the paper of Prof. Koloman Balogh, of Pesth, published in 1869,‡ and that of Dr. V. Feltz of Strasbourg, in 1870.§ Both these authors have failed to see the white blood corpuscles pass through the coats of the small vessels in the manner described by Cohnheim, and deny the existence of stomata, between the cells of the vascular epithelium, large enough to permit such a wandering to occur.

It is well known to you General, that after I had perused Cohnheim's paper I procured a number of frogs, and having on hand a small quantity of Wourara, the gift of my friend Dr. S. Weir Mitchell of

---

*Ueber Entzündung und Eiterung. Virchow's Archiv. Bd XL. S. 1.

†Microscopical Examination of some of the principal Tissues of the Animal Frame as observed in the Tongue of the living Frog, Toad, &c. London, Edinburg and Dublin Philosophical Magazine, Vol. XXIX, p. 271, (1846). Microscopical observations on the Perforation of the Capillaries by the Corpuscles of the Blood, and on the Origin of Mucous and Pus Globules. Ib. p. 397.

‡In welchem Verhältnisse steht das Heraustreten der farblosen Blutzellen durch die unversehrten Gefässwandungen zu der Entzündung und Eiterung? Virchow's Archiv. Bd XLV. S. 19. Readers inclined to attach importance to this paper should read the caustic criticism of Dr. Alexis Schklarewski of Moscow. Ib. Bd XLVI. S. 116.

§Recherches Experiméntales sur le passage des Leucocytes à travers les parois vasculaires. Journal de l'Anatomie et de la Physiologie. Jan. & Feb. 1870, p. 33.

Philadelphia, I carefully repeated many of the experiments described. I received the impression from what I saw that Cohnheim was a most conscientious observer, who had described as faithfully as possible the impressions made upon him. Certainly the results I obtained, by following his methods of producing inflammation in the cornea and mesentery of frogs, could be described in his very language without drawing upon the imagination. Nevertheless my other duties did not leave me sufficient time for an exhaustive research in this difficult domain, and it is far from my present purpose to enter into a critical discussion of the subject. It is simply my desire to offer a brief description, illustrated by Photo-micrographs, of certain preparations in the Microscopical Section of the Museum, which bear upon some of the points involved, and thus to contribute what is in my power towards the important object of arriving at certainty with regard to the facts on which our future theories of inflammation are to rest.

Most of the preparations here referred to are examples of the results attainable by staining the tissues with a dilute solution of the nitrate of silver. This reagent has been employed for various histological purposes during the last ten years, and has attracted attention especially in connection with the cornea, the various forms of connective tissue, the ultimate branches of the lymphatics and the boundaries of the cells which constitute epithelial surfaces. General attention was first drawn to its use by Dr. F. von Recklinghausen, of Berlin, in 1860,* and further particulars were contributed during 1861, by Prof. His, of Basel,† who would appear to have already employed the reagent for several years. In 1862 Von Recklinghausen published his work on the lymphatics,‡ which contains a detailed account of many elaborate experiments with regard to the action of silver solutions on the tissues, and in 1863 Dr. Ernst Oedmanson, of Stockholm,§ gave a description of their behavior when applied to epithelial surfaces, and described and figured the so-called stomata which play so important a part in the theory of Cohnheim. During 1865 and 1866 the epithelium of the capillary bloodvessels, as shown by silver, was described by several observers, among whom Dr N. Chrzonszczewsky, of Charkow,‖ may be particularly mentioned.

The perusal of these papers led me to make a number of experiments myself, and to have others made by my assistants at the Museum, the results of which are now to be described.

If a dilute solution of nitrate of silver is brushed over a clean epithelial surface taken from a recently killed animal, and the tissue after washing with distilled water is exposed for a short time to the action of sunlight, it will be found on microscopical examination that a brownish black precipitate of silver has been produced at the boundaries of the epithelial cells, while the cells themselves are comparatively but little stained, or if the manipulation has been carefully conducted, are not stained at all. For this purpose I have most frequently employed, at the Museum, a solution made by dissolving one part of crystallized nitrate of silver in four hundred parts of distilled water, but considerable variation on either side of this strength does not much modify the result, provided the solution is well washed off before the tissue is exposed to the light.

If the same solution is injected into the bloodvessels, the lining epithelium is handsomely mapped out in all those membranous and superficial parts in which a ready exposure to the action of light is practicable, and although in the parenchymatous organs, such as the liver, the spleen, the kidneys, &c., the juices of the tissues are apt to interfere with the reaction, yet even here occasional success may be attained.

---

*Eine Methode, mikroskopische hohle and solide Gebilde von einander zu unterscheiden. Virchow's Archiv. Bd. XIX. S. 451.

†Ueber das Verhalten des Salpetersauren Silberoxyds zu thierischen Gewebsbestandtheilen. Ib. Bd. XX. S. 207.

‡Die Lymphgefässe und ihre Beziehung zum Bindegewebe. Berlin, 1862.

§Beitrag zur Lehre von dem Epithel. Virchow's Archiv. Bd XXVIII. S. 361.

‖Ueber die feinere Structur der Blutcapillaren. Ib. Bd. XXXV. S. 169. C. J. Eberth in his article on the bloodvessels in Stricker's Handbook (Handbuch der Lehre von den Geweben &c. Leipsic, 1869. II. Lief: S. 202.) enumerates the following microscopists as having described the epithelium of the capillaries prior to Chrzonszczewsky. *Hoyer.* Archiv für Anatomie. Jan. 18, 1865. *Auerbach.* Breslauer Zeitung. Feb. 17, 1865. *Eberth.* Sitzungsberichte der physikal. med. Gesellschaft zu Würzburg. Feb. 18, 1865. Medicinisches Centralblatt, No. 13, 1865. Würzburger Naturwissenschaftliche Zeitschrift. Bd VI, 1866. *Aeby.* Medicinisches Centralblatt. No. 14, 1865.

In practice it is often found advantageous to combine the silver solution, intended for injection, with a certain amount of gelatine, by which the bloodvessels are kept handsomely distended and the beauty of the preparation is much increased. This plan was proposed by Chrzonszczewsky in the paper already quoted. His formula, which I have found to work well, is as follows: Half an ounce of fine gelatine is dissolved in four ounces of distilled water and to this is added a solution of one scruple of nitrate of silver in two fluid drachms of distilled water. After injecting with this fluid, the tissue is exposed to the light precisely as after the use of the simple silver solution.

There are preserved in the Microscopical Section of the Museum a number of silver stainings in which the epithelium has been thus mapped out on the skin, the peritoneum, the lymphatic-sacs of frogs, and the bloodvessels. These preparations, after the action of the silver, have been mounted in Canada balsam with or without the previous staining of the nuclei with carmine. The detailed steps of the process may prove useful to some readers. The silver staining having been successfully accomplished, the nuclei are tinted preferably by the solution of carmine in borax, described by Thiersch in his work on epithelial cancer.* It is prepared as follows: Four parts of borax are dissolved in fifty-six parts of distilled water and one part of carmine added to the solution; one volume of this fluid is mixed with two volumes of absolute alcohol, and after crystals have formed the mixture is filtered. The filtrate may be used for staining, but if the crystals of carmine and borax which remain on the filter are dissolved in a small quantity of distilled water, I find the solution thus obtained answers a still better purpose. The portion of tissue to be studied is soaked in this solution until colored deep red. It is afterwards treated with a saturated solution of oxalic acid in alcohol, by which all color is gradually removed except from the nuclei. So soon as this is accomplished the piece is to be carefully washed in alcohol, then soaked in absolute alcohol and finally mounted in a solution of dried Canada balsam in chloroform or benzole. The treatment by oxalic acid, subsequently to the action of the carmine-borax solution, has the additional effect of altering the purplish-red color, derived from that fluid, to the brilliant hue obtained by the use of the ammoniacal solution of carmine ordinarily employed in histology. The latter has the disadvantage of being apt to dissolve out the previously produced silver staining, an annoyance completely avoided by the carmine-borax solution.

Preparations carefully made by the above process closely resemble the fresh tissues, as they appear after staining if immersed in glycerine or syrup; they are somewhat more transparent, but not inconveniently so, and possess the great advantage of keeping unchanged for an indefinite period of time.

After these preliminary remarks, I proceed at once to the description of the photographs.

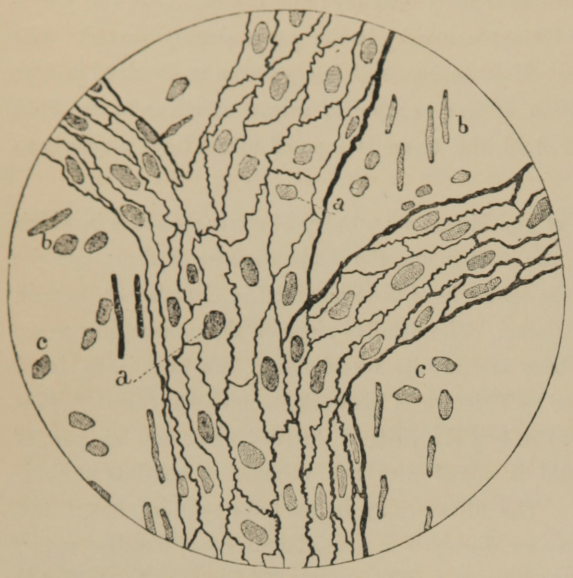
I. Photograph representing several venous radicles uniting to form a small vein, in the muscular coat of the urinary bladder of the frog. Negative No. 102, New Series. From preparation No. 3378, Microscopical Section. Magnified 400 diameters by Wales's $\frac{1}{8}$th objective, illuminated by the Magnesium lamp. The preparation was made by Dr. J. C. W. Kennon.

The principal venous trunk represented in this photograph is 1-400th of an inch in diameter. It is formed by the union of three smaller radicles, of which that on the left hand is much out of focus. Another smaller radicle, also much out of focus, joins the trunk on the left, near the bottom of the picture. The walls of the venous trunk, and of those of its branches which are in focus, are plainly seen to be formed of somewhat irregular epithelial cells, which vary in shape and size, averaging 1-500th of an inch in length and 1-2200th in breadth. The boundary of each cell is indicated by a zigzag black line. In each of the cells which is accurately in focus, a smooth, oval nucleus, 1-2800th of an inch in length, is visible. In examining the original preparation, by changes in the fine adjustment of the microscope, similar nuclei can be seen in each of the epithelial cells. These nuclei, being brilliantly stained with carmine, contrast sharply with the black cell-boundaries resulting from the silver imbibition. By a still further alteration of the fine adjustment, the cells and nuclei of the opposite side of the vein are brought into view.

---

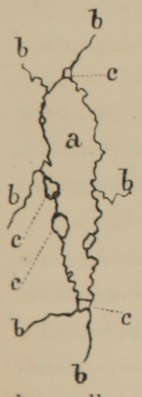
*Der Epithelialkrebs. Leipzic, 1865. S. 92.

In the tissue external to the vein, two kinds of nuclei are shown in the photograph. The first are narrow and elongated, averaging about 1-1500th of an inch in length and 1-9000th in breadth. These are the nuclei of the fibre-cells of the muscular coat of the bladder. The fibre-cells themselves are not shown in carmine stainings, but are readily demonstrated in fresh preparations by the action of solutions of osmic acid, or of chloride of gold. Indications of the muscular bands formed by the union of these fibre-cells are, however, seen in the photograph, particularly on each side of the principal venous trunk. The second variety of nuclei are oval, about 1-3000th of an inch long, and belong to the connective tissue of the bladder. The cells in which these nuclei lie are not seen, the action of the carmine being limited to the nuclei. They can, however, readily be demonstrated in fresh preparations by gold-chloride and some other reagents. The cut represents the outlines of a portion of the photograph; a, a, are the nuclei of the vascular epithelium; b, b, the nuclei of the muscular fibre-cells; c, c, those of the connective tissue.



II. Photograph representing a small vein from another portion of the same preparation. Negative No. 195, New Series. Magnified 1000 diameters by Powell and Lealand's immersion 1-16th objective, illuminated by the Magnesium lamp. One of the epithelial cells near the centre of the vessel is particularly well defined, and shows its nucleus handsomely; the adjacent cells, not lying in the same plain, are many of them partly out of focus, but their boundaries can readily be traced, and the nuclei of several of them are well defined. Four black spots, seen in the course of the vessel, are blood corpuscles much out of focus.

III. Photograph representing the stomata between the epithelial cells of a vein 1-50th of an inch in diameter in the mesentery of the frog. Negative No. 40, New Series. From preparation No. 3276, Microscopical Section. Magnified 400 diameters by Wales's ⅛th objective. The preparation was made by myself.



Owing to the curved form of the vein, but a small portion of its surface is in focus. In this portion the silver stained boundaries of several of the epithelial cells of the vein are visible, and display in their course certain remarkable forms, which may be compared to the Wormian bones of the cranial sutures. These are the so-called stomata. They are irregularly rounded in form, and vary from the 1-10000th to the 1-4000th of an inch in long diameter. Those shown in the photograph present a clear central space, bounded by a sharp, black outline, which is sometimes even thicker than the boundaries of the cells themselves. The nuclei of the epithelial cells are not shown. The cut exhibits one of these cells, a, with portions of the boundaries of adjacent cells, b, b, b, and the stomata, c, c, c.

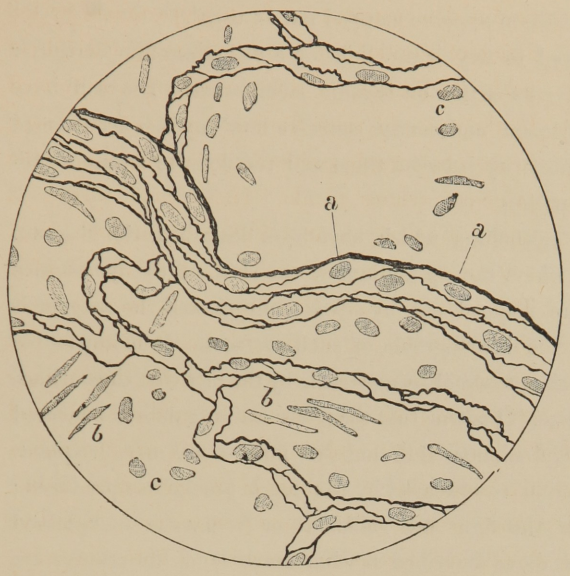
IV. Photograph representing the stomata between the epithelial cells of a vein, 1-100th of an inch in diameter, in the mesentery of the frog. Negative No. 224, New Series. From preparation No. 3062, Microscopical Section. Magnified 400 diameters by Wales's ⅛th objective. The preparation was made by Dr. Kennon.

The vein having collapsed, the epithelial cells of the lower wall come into focus in places, and so somewhat complicate the representation. The stomata are abundantly present, but none of them equal in size the largest shown in the last photograph; in several places, moreover, black spots, similar to the other stomata in shape and size, may be observed in the cell boundaries.

V. Photograph representing the stomata of a vein, 1-1000th of an inch in diameter, in the mesen-

tery of the frog. Negative No. 194, New Series. From preparation No. 3276, Microscopical Section. Magnified 400 diameters by Wales's $\frac{1}{8}$th objective, illuminated by the Magnesium lamp. The small vein represented comes well into view, while the nuclei of the surrounding tissue are seen out of focus on each side of it. Several of the stomata present clear centres, while others are black and opaque throughout; they average 1-10000th of an inch in diameter.

VI. Photograph representing a minute artery, with part of the adjoining net-work of capillaries, from the muscular coat of the urinary bladder of the frog. Negative No. 220, New Series. From Preparation No. 3378, Microscopical Section. Magnified 400 diameters by Wales's $\frac{1}{8}$th objective. The field is crossed by a small artery, 1-1700th of an inch in diameter. Its epithelial cells are longer in proportion to their width than those of the veins. They average 1-400th of an inch in length, and have nuclei similar to those of the venous epithelium. Wherever the capillaries come into focus the epithelium of their walls is also plainly shown. In the intervascular spaces the nuclei of the muscle and connective tissue appear as in the first photograph. The cut presents an outline of a part of the picture; a, a, are the nuclei of the vascular epithelium; b, b, those of the muscle; c, c, those of the connective tissue.



VII. Photograph representing a portion of the view presented by the last picture. Negative No. 223, New Series. Magnified 1000 diameters by Powell and Lealand's immersion 1-16th objective. The spindle shaped forms of the epithelial cells of the arteries, and the characters of their nuclei are plainly shown.

VIII. Photograph representing a small artery in the mesentery of the frog. Negative No. 184, New Series. From preparation No. 3267, Microscopical Section. Magnified 500 diameters by Wales's $\frac{1}{8}$th objective, illuminated by the Calcium light. The preparation was made by myself. The artery shown, measures 1-280th of an inch in diameter. It is marked by both transverse and longitudinal silver lines. The former are exterior to the latter, as is readily demonstrated in the preparation by the use of the fine adjustment. The longitudinal lines belong to the epithelium, while the transverse markings indicate the boundaries of the circular fibre-cells of the muscular coat, which are usually mapped out in this manner in arteries of moderate size, the silver solution reaching them by imbibition. The epithelial cells of arteries of this size, are narrower in proportion to their length, than those of smaller twigs, such as that shown in the last two photographs. In the photograph it is somewhat difficult, in many places, to make out their boundaries, as the margins of the cells of the opposite wall come into focus and complicate the appearance. In the study of the original preparation this difficulty is readily overcome by manipulating the fine adjustment. On each side of the artery, the numerous nuclei of the surrounding tissue come more or less distinctly into view.

IX. Photograph representing the epithelium of a capillary, in the muscular coat of the urinary bladder of the frog. Negative No. 216, New Series. From preparation No. 3378, Microscopical Section. Magnified 1000 diameters by Powell and Lealand's immersion 1-16th objective, illuminated by the Calcium light. The capillary which crosses the centre of the field measures 1-2300ths of an inch in diameter. The epithelial cells are narrower in proportion to their length than those of the veins. Their nuclei are quite similar to those of the venous epithelium.

The foregoing description of individual photographs will serve to give a correct idea of the epithelium lining the small arteries, veins, and capillaries, as shown in a considerable number of preparations pre-

served in the Museum, and as observed by me many times in tissues extemporaneously prepared. Both Balogh and Feltz would seem to have been singularly unfortunate in their silver stainings, for they describe the appearances produced as irregular and contradictory. Balogh explains the black lines he occasionally saw in the vessels after silver injections as due to the precipitate of silver occurring preferably on folds in the lining membrane, caused by the irregular shrinkage of the vessel produced by the silver injection, an error readily corrected by combining gelatine with the solution of silver injected, the vessels are thus equably and smoothly distended, yet the epithelium appears mapped out as usual.

Feltz asserts that if a solution of silver be allowed to dry in the light on a collodium film, irregular black lines are produced, quite like those observed after its action on organic membranes. I myself have examined the irregular figures produced by this experiment, and cannot conceive how any one accustomed to the precise study of organic forms can see any similarity between them and the definite outlines produced by the action of silver solutions on epithelial surfaces.

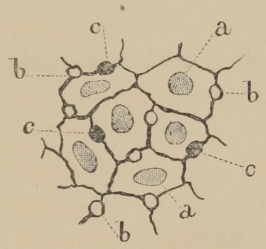
Besides the preparations exhibiting the vascular epithelium which have been described, the Museum possesses, as I have already mentioned, a number in which the epithelium of the skin, of the lymph-sacs of frogs, of the peritonæum and of other surfaces, are mapped out by silver staining, and the reagent is continually employed by myself and my assistants in the investigation of such surfaces. It is impossible for any one who has had such opportunities for observation, to avoid being struck by the fact that the outlines obtained have a definite form and character for each tissue. It is true that the silver staining does not succeed as frequently as carmine staining does, that its use requires more skill and that failures are more frequent. Sometimes too much action takes place and everything is obscured by the black precipitate produced; sometimes either because the tissues are not fresh, or the light not sufficient, or from some unexplained reason, the solution does not act at all; but the forms above described as characteristic of the arteries are never observed in the veins, never do the outlines produced on the surface of the skin resemble those seen on the peritonæum, in the lymph-sacs, or in the vessels; each membrane permits only the formation of its own characteristic outlines, never of those belonging to another tissue; moreover, in all cases where it is possible to observe the shape of the epithelial cells without the use of reagents, or to isolate them, the forms thus ascertained correspond precisely with those mapped out by the silver solution, and when after the action of silver, carmine staining is resorted to, the nuclei thus made visible correspond in position to the places they ought to occupy, if in fact the silver had mapped out the cell-boundaries as I certainly believe it does. Whether the discoloration is in the cell wall, or in the cement or matrix by which the adjacent cells are held together, is a more difficult question, and one into which I do not propose to enter at the present time. It is enough for the purposes of this paper that the peripheries of the cells or the substance just external to them, exhibits a much more speedy and intense reaction with the nitrate than the cell contents do, and must therefore differ more or less from these in composition.

Having arrived at this conclusion with regard to the general interpretation of the action of silver on epithelial surfaces, the question of the true meaning of the so-called stomata next demands consideration. They are to be observed most abundantly, as may be inferred from the photographs described, in veins of moderate size. I have found them largest and most numerous in veins 1-50th of an inch in diameter or even larger, and they become smaller and rarer in smaller branches. They are comparatively infrequent in the capillaries and still more so in the small arteries; the Museum however possesses preparations showing them in both. I have moreover concluded from my own observations that in number and size they vary in vessels of the same dimensions in different parts of the body. Thus, for example, in the veins of the mesentery of the frog they are larger and more abundant than in veins of the like dimensions in the urinary bladder of the same animal.

In figure they are rounded, oval or oblong. I have measured them as large as 1-4000ths of an inch in diameter, but smaller ones 1-5000ths to 1-6000ths of an inch are more common and the smallest and most frequent do not exceed 1-10000ths of an inch. Sometimes they present clear centres sharply mapped out by black boundaries, sometimes forms of the same size and character are opaque and black throughout, and this has has been interpreted as due to variations in the composition of the fluid by which the opening

is occupied, which sometimes precipitates the silver solution while at other times it does not, and the action is limited to the solid margins of the pore. They are almost invariably found in the marginal line between adjacent epithelial cells, and the rare cases in which I have observed them apparently in the cells themselves, are probably to be explained by the adjacent margins having from some cause escaped the influence of the silver salt. From my study of these peculiar inter-cellular forms, I am inclined to regard with favor the opinion that they are actual openings in the epithelial layer. It may aid others in arriving at a conclusion on the subject, if I here present a photograph of the stomata in the external epithelium of the skin of the frog through which, as is well known, a rapid transudation of liquid habitually occurs.

X. Photograph representing a silver staining of the external epithelium of the frog's skin. Negative No. 22, New Series. From preparation 3036, Microscopical Section. Magnified 400 diameters by Wales's $\frac{1}{8}$th. The preparation was made by myself. The epithelium of this surface consists of a number of layers and the silver has penetrated in different portions of the skin to various depths. In the photograph the epithelial cells of the upper surface are sharply mapped out, while the boundaries of the cells of several of the deeper layers are seen out of focus beyond. The cells are hexagonal in shape and average 1-1300th of an inch in diameter. Many of the nuclei have been somewhat tinted by the silver, a circumstance which is not unfrequent if the silver action is intense. In the boundaries of the epithelial cells may be seen very many little rings, with black margins and clear centres, averaging 1-5000th of an inch in diameter, and also many similar forms, of the same size and occupying like positions, which are quite black and opaque throughout. In some parts of the preparation, from which the photograph was taken, almost all the rings are black and opaque, while in other portions almost all present clear centres. The view which regards these rings as true pores certainly appears to me to require fewer suppositions than any other. The cut represents an outline of a portion of this photograph; a, a, the nuclei of the epithelial cells; b, b, the stomata; c, c, stomata which have become black and opaque throughout. It has been urged, however, by Balogh, that even if the stomata described in the vascular epithelium are admitted as such they are not large enough to permit the passage of the white blood corpuscles which, as is well known, average about 1-3000th of an inch in diameter. But even if we discard the supposition that the pores may be stretched open and made larger by the distended condition of the vessels of inflamed parts, there appears to me no difficulty in understanding how a white corpuscle might pass through the smallest of the stomata I have described. An opening 1-10000th of an inch in diameter is only a little less than one-third the average diameter of the white corpuscles, and any one who has seen the extraordinary modifications of form which these little masses of protoplasm undergo in the course of their so called "amœboid movements," would readily credit their capability of passing through such apertures. As the amœboid movement does not occur in the white corpuscles while rolled along in the torrent of the circulation, but only when the movement of the blood is arrested more or less completely, the fact that large numbers of white corpuscles do not habitually pass through the vascular walls into the tissues will not militate against the notion of patulous orifices. That a passage of the white blood corpuscles through the vascular walls does actually occur, is shown by the next picture.



XI. Photograph representing white corpuscles in various phases of the amœboid movement, in the external coat of a small vein of the muscular coat of the stomach of a mare. Negative No. 46, New Series. From preparation No. 3382, Microscopical Section. Magnified 400 diameters by Wales's $\frac{1}{8}$th objective. The preparation was made by Dr. E. M. Schæffer.

This preparation is one of a number of sections made from the stomach of a mare dead of gastro-enteritis. In these sections, which are stained with carmine and mounted in Canada balsam after the method described in the early portion of this paper, it was found that many of the small veins of the sub-peritoneal connective tissue and of the muscular coat were surrounded by white corpuscles fixed in all stages of the amœboid movement. In a number of places where the sections pass transversely through the veins, the white corpuscles can be observed in the interior of the vein, and in the vascular walls as

well as in the adjacent tissue. The series of preparations gives a satisfactory demonstration of the wandering-of the white corpuscles. I have made efforts to preserve the frog's mesentery permanently, in a number of the cases in which I have observed the same process in that membrane, but hitherto without success.

It will be seen from the foregoing details that, so far as the structure of the vascular walls and the passage of the white corpuscles through them are concerned, the facts appear to be on the side of Cohnheim. How then with regard to the doctrine of inflammation which he builds upon these facts and upon his corneal studies? Does the creeping out of the white corpuscles constitute the essence of the inflammatory process? Do these little moveable masses of living protoplasm furnish the germs for the elements of new formations? Have pus corpuscles no other origin? Are the processes which go on in the cells of the inflamed tissue purely passive, mere phenomena of retrograde metamorphosis?

I find the evidence insufficient as yet to afford satisfactory answers to such questions. The observations made by Cohnheim on the connective tissue corpuscles of the tongue of the frog are not conclusive in themselves, and Stricker's studies on the same subject* show the necessity of further labor in this direction before the possible multiplication of these elements in inflammation can be denied. As to the doctrine that the white corpuscles, after their escape from the bloodvessels, are transformed into the elements of normal or pathological tissues, the facts hitherto brought forward can scarcely be said to do more than raise it to the rank of an ingenious hypothesis. The actual steps of this transformation, if it does occur, have yet to be observed.

In conclusion I may remark that, as the preparations referred to in this paper form a portion of the Microscopical Collection of the Museum, they can be examined by any professional microscopist who may visit that institution.

The photographs which accompany this paper were prepared by myself in accordance with the methods described on former occasions.

I have the honor to be, General,

Very respectfully,

Your obedient servant,

J. J. WOODWARD,

Assistant Surgeon and Brevet Lieutenant Colonel, U. S. Army,
In charge of the Record and Pension Division, and of the Medical, Microscopical and Comparative Anatomy Sections of the Army Medical Museum.

---

*Studien aus dem Institute für Experimentelle Pathologie in Wien aus dem Jahre 1869. Wien, 1870.

WAR DEPARTMENT,

Surgeon General's Office, Army Medical Museum.

VEINOUS RADICLES UNITING TO FORM A SMALL VEIN.

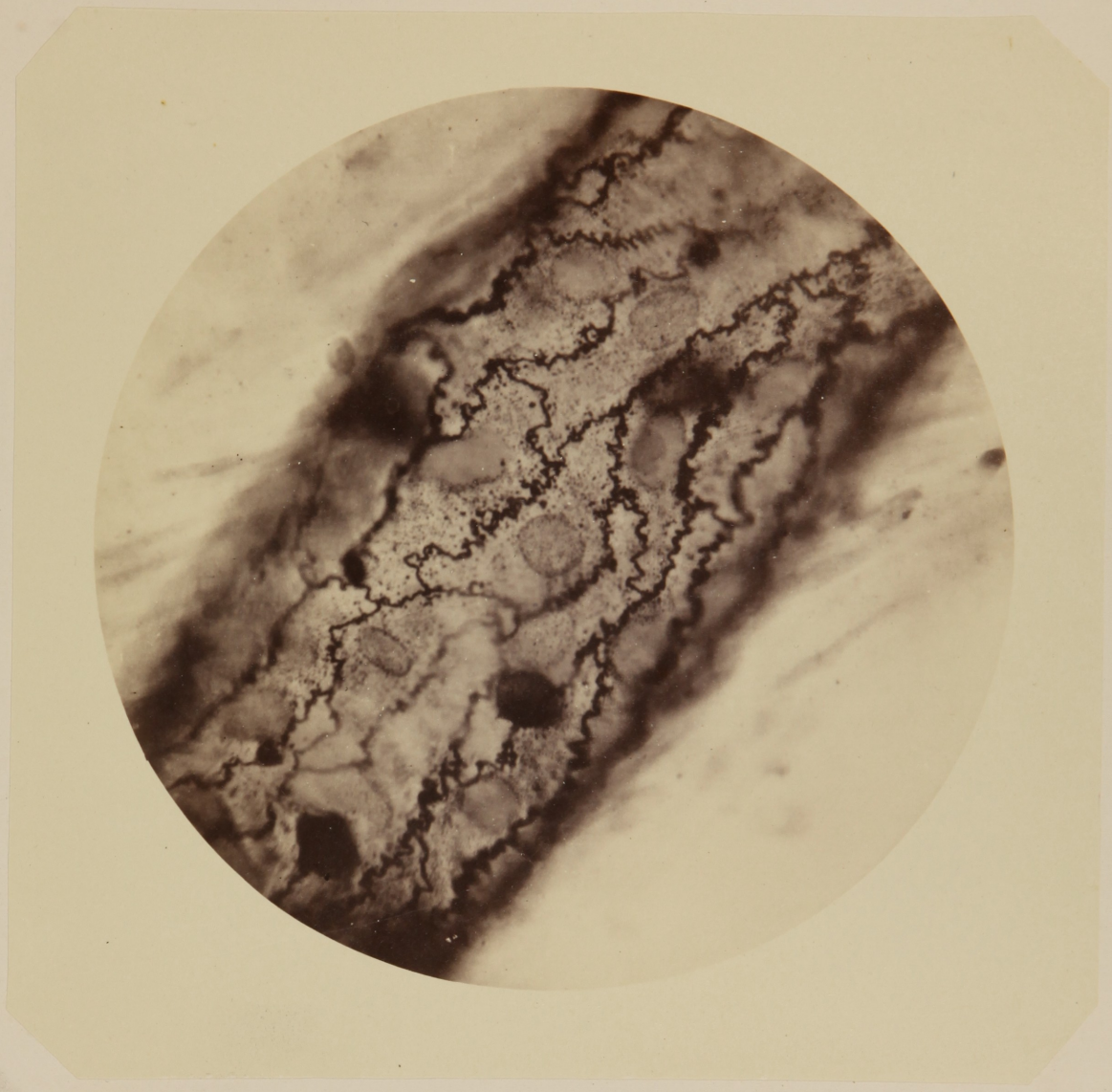
From the muscular coat of the Urinary bladder of the Frog.

Showing the epithelium of the vessels. The preparation copied, (No. 3378, Microscopical Section) had been injected with nitrate of silver, stained with carmine, and mounted in Canada balsam.

Magnified 400 diameters by Wales' one-eighth objective.
Photo-Micrographic Negative No. ~~[illegible]~~ New Series.
Taken by the Magnesium Light. 102

By Brevet Lieutenant Colonel J. J. WOODWARD, Asst. Surg., U. S. A.

By order of the Surgeon General.



WAR DEPARTMENT,

Surgeon General's Office, Army Medical Museum.

PORTION OF A SMALL VEIN.

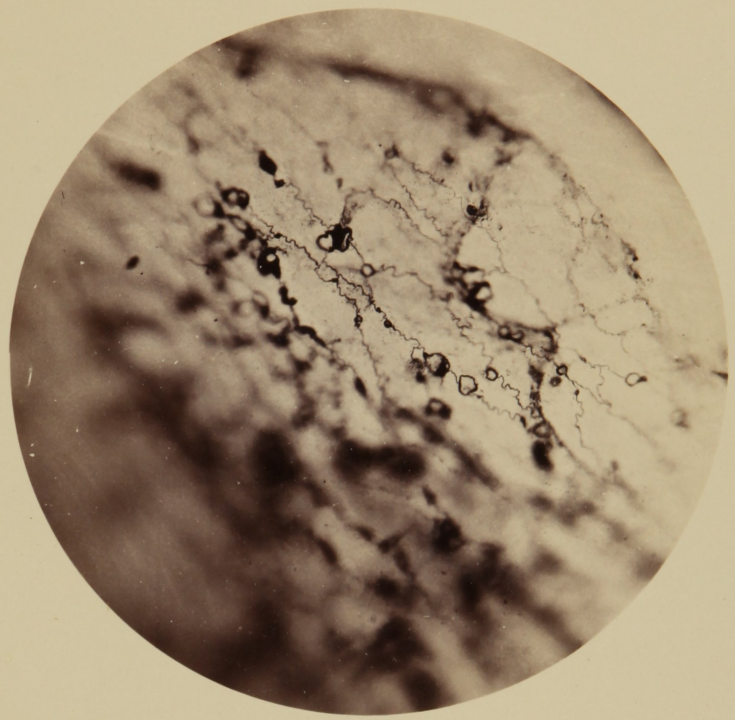
From the muscular coat of the Urinary bladder of the Frog.

Showing the epithelium of the vessel. The preparation copied, (No. 3378, Microscopical Section) had been injected with nitrate of silver, stained with carmine, and mounted in Canada balsam.

Magnified 1000 diameters by Powell & Lealand's immersion one-sixteenth objective.
Photo-Micrographic Negative No. 195. New Series.
Taken by the Magnesium Light.

By Brevet Lieutenant Colonel J. J. WOODWARD, Asst. Surg., U. S. A.

By order of the Surgeon General.



WAR DEPARTMENT,

Surgeon General's Office, Army Medical Museum.

STOMATA IN THE EPITHELIUM OF A VEIN, one-fiftieth of an inch in diameter.

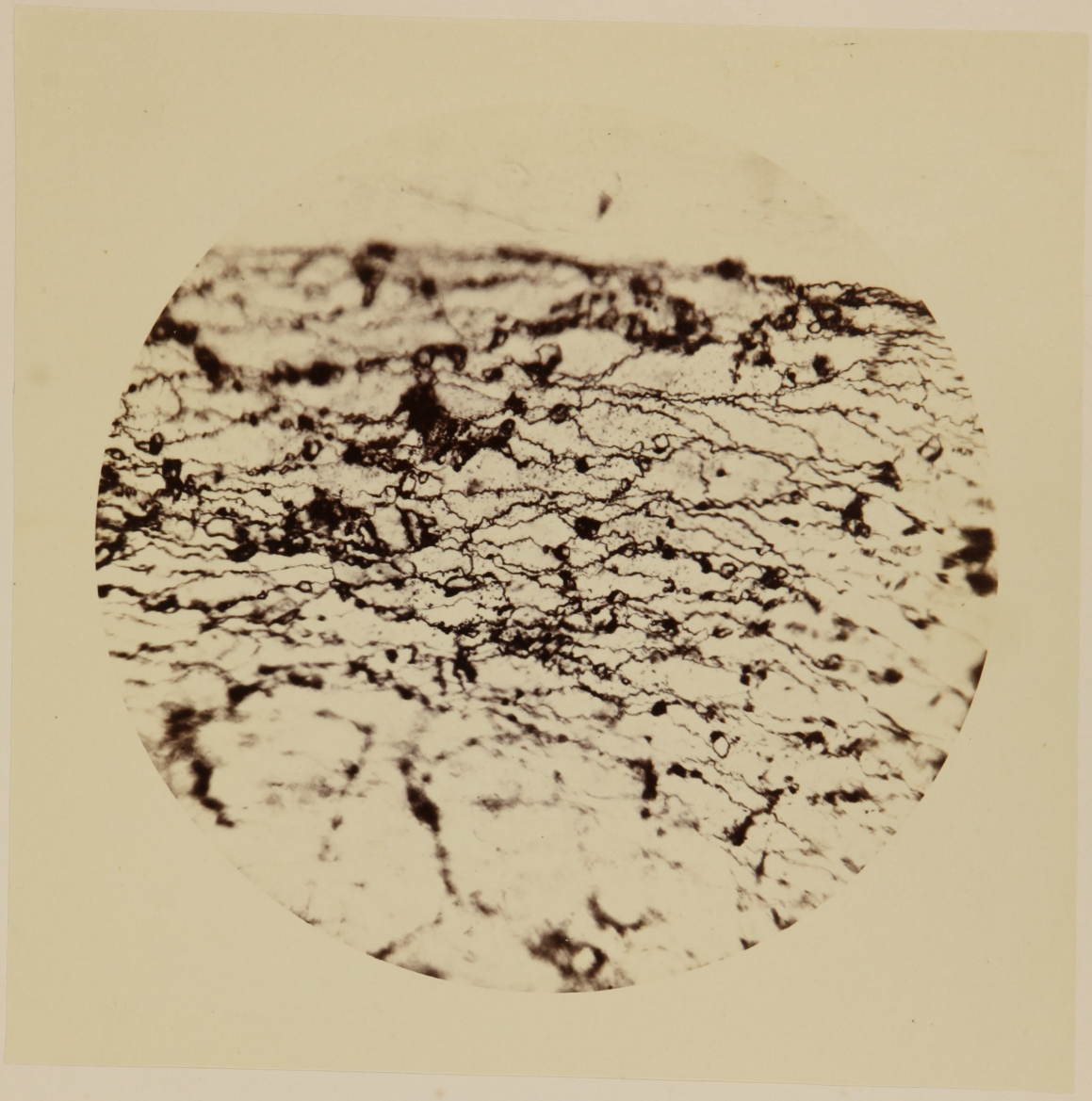
From the Mesentery of a Frog.

The preparation copied, (No. 3276, Microscopical Section) had been injected with nitrate of silver, and mounted in Canada balsam. The wall of the vein being curved, a part of the view only is in focus.

Magnified 400 diameters by Wales' one-eighth objective.
Photo-Micrographic Negative No. 40. New Series.

By Brevet Lieutenant Colonel J. J. WOODWARD, Asst. Surg., U. S. A.

By order of the Surgeon General.



WAR DEPARTMENT,

Surgeon General's Office, Army Medical Museum.

STOMATA IN THE EPITHELIUM OF A VEIN, one-hundredth of an inch in diameter.

From the Mesentery of a Frog.

The preparation copied, (No. 3062, Microscopical Section) had been injected with nitrate of silver, and mounted in Canada balsam. The vein having collapsed, portions of the more distant wall come into view, and from the curvature of the surface parts are out of focus.

Magnified 400 diameters by Wales' one-eighth objective.
Photo-Micrographic Negative No. 224. New Series.

By Brevet Lieutenant Colonel J. J. WOODWARD, Asst. Surg., U. S. A.

By order of the Surgeon General.

WAR DEPARTMENT,

Surgeon General's Office, Army Medical Museum.

STOMATA IN THE EPITHELIUM OF A VEIN, one-thousandth of an inch in diameter.

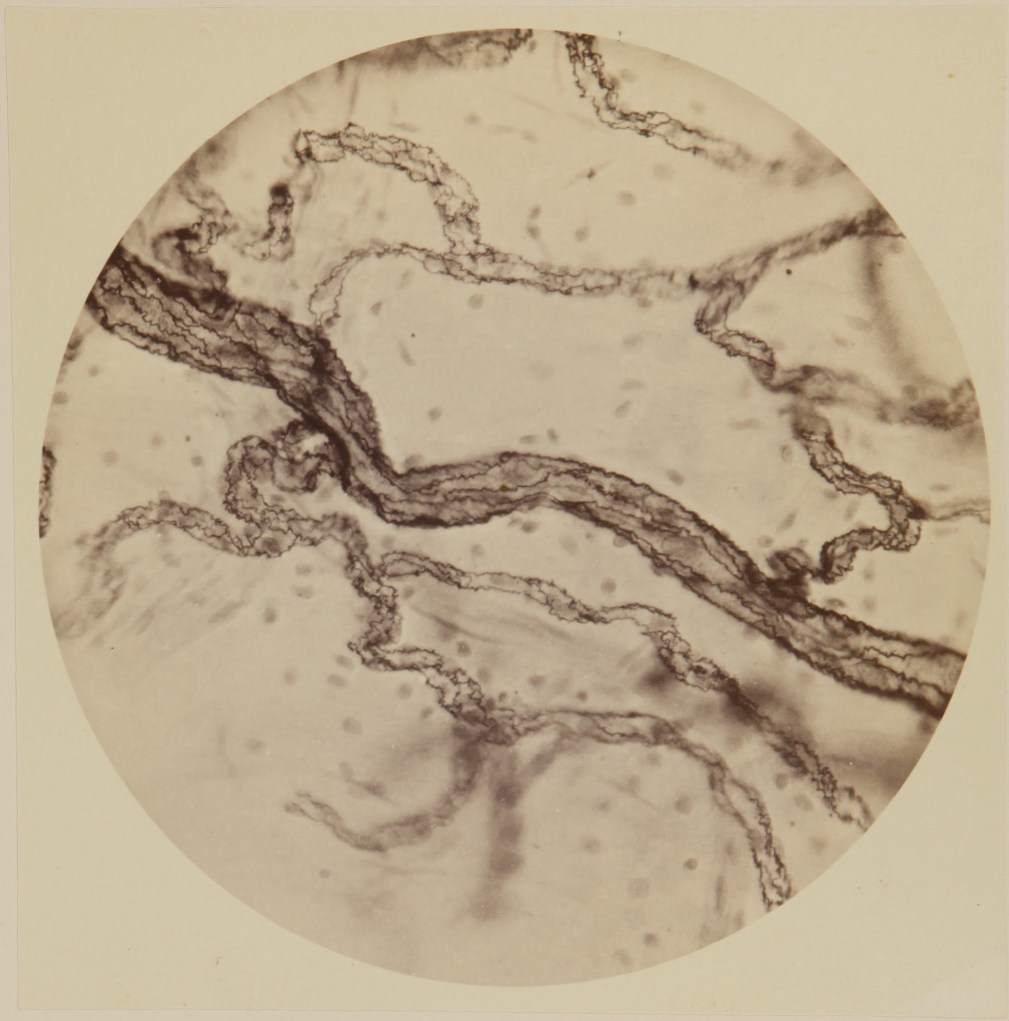
From the Mesentery of a Frog.

The preparation copied, (No. 3276, Microscopical Section) had been injected with nitrate of silver, stained with carmine, and mounted in Canada balsam.

Magnified 400 diameters by Wales' one-eighth objective.
Photo-Micrographic Negative No. 194. New Series.
Taken by the Magnesium Light.

By Brevet Lieutenant Colonel J. J. WOODWARD, Asst. Surg., U. S. A.

By order of the Surgeon General.



WAR DEPARTMENT,

Surgeon General's Office, Army Medical Museum.

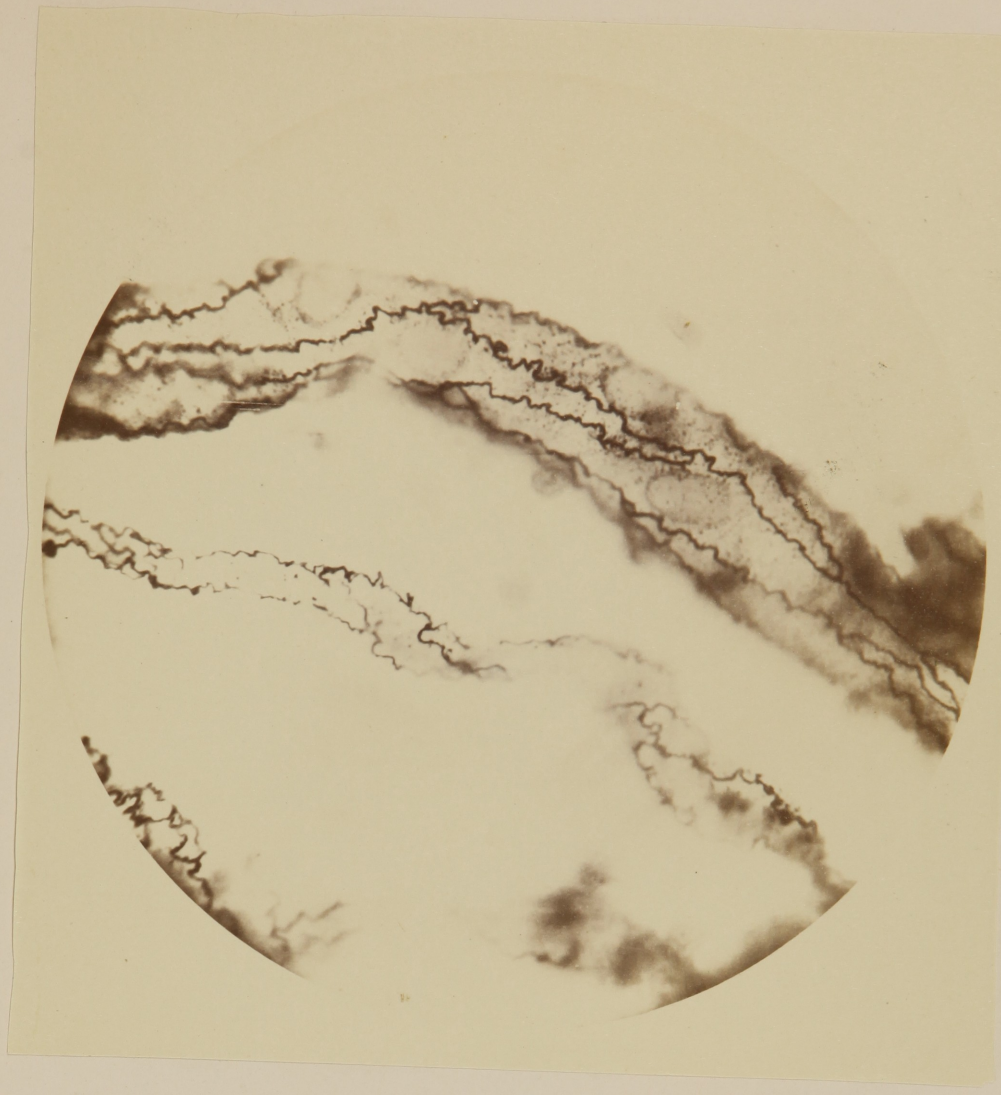
SMALL ARTERY AND CAPILLARIES, showing epithelium.
From the muscular coat of the Urinary bladder of the Frog.

The preparation copied, (No. 3378, Microscopical Section) had been injected with nitrate of silver, stained with carmine, and mounted in Canada balsam.

Magnified 400 diameters by Wales' one-eighth objective.
Photo-Micrographic Negative No. 220. New Series.

By Brevet Lieutenant Colonel J. J. WOODWARD, Asst. Surg., U. S. A.

By order of the Surgeon General.



WAR DEPARTMENT,

Surgeon General's Office, Army Medical Museum.

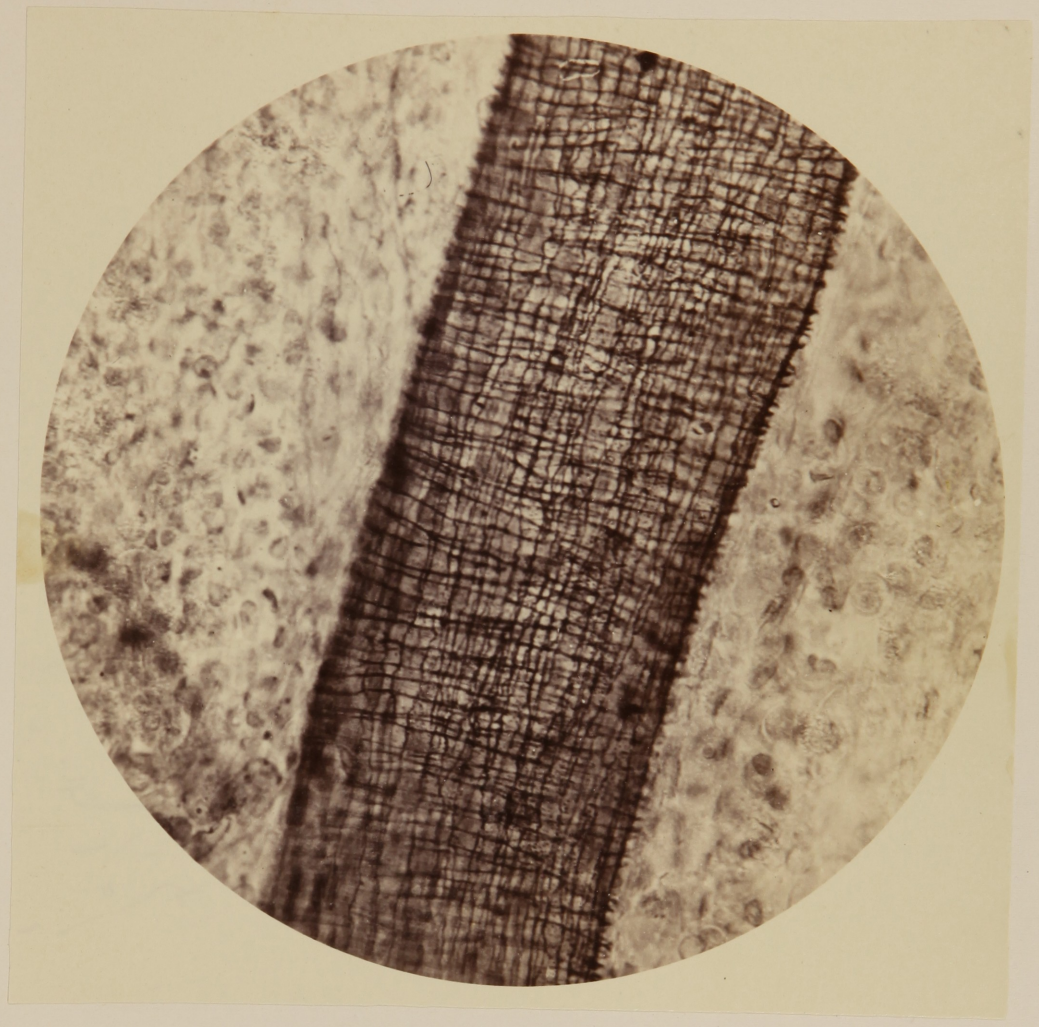
SMALL ARTERY AND CAPILLARIES, showing epithelium.
From the muscular coat of the Urinary bladder of the Frog.

The preparation copied, (No. 3378, Microscopical Section) had been injected with nitrate of silver, stained with carmine, and mounted in Canada balsam.

Magnified 1000 diameters by Powell & Lealand's immersion one-sixteenth objective.
Photo-Micrographic Negative No. 223. New Series.

By Brevet Lieutenant Colonel J. J. WOODWARD, Asst. Surg., U. S. A.

By order of the Surgeon General.



WAR DEPARTMENT,

Surgeon General's Office, Army Medical Museum.

SMALL ARTERY, showing epithelium and circular muscular fibre cells.

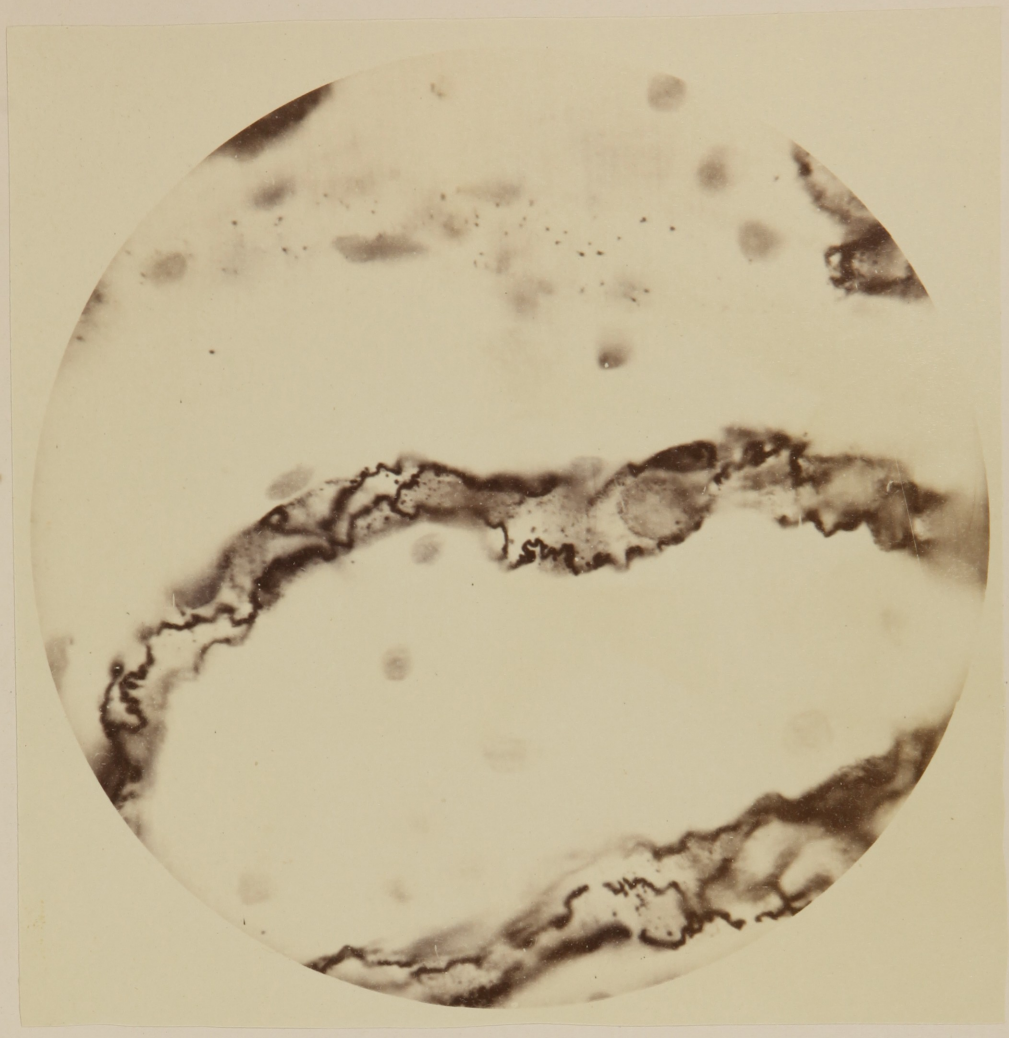
From the Mesentery of a Frog.

The preparation copied, (No. ~~3175~~ 3267, Microscopical Section) had been injected with nitrate of silver, stained with carmine, and mounted in Canada balsam.

Magnified ~~[illegible]~~ 500 diameters by Wales' one-eighth objective.
Photo-Micrographic Negative No. 184. New Series.

By Brevet Lieutenant Colonel J. J. WOODWARD, Asst. Surg., U. S. A.

By order of the Surgeon General.



WAR DEPARTMENT,

Surgeon General's Office, Army Medical Museum.

CAPILLARY, SHOWING EPITHELIUM.

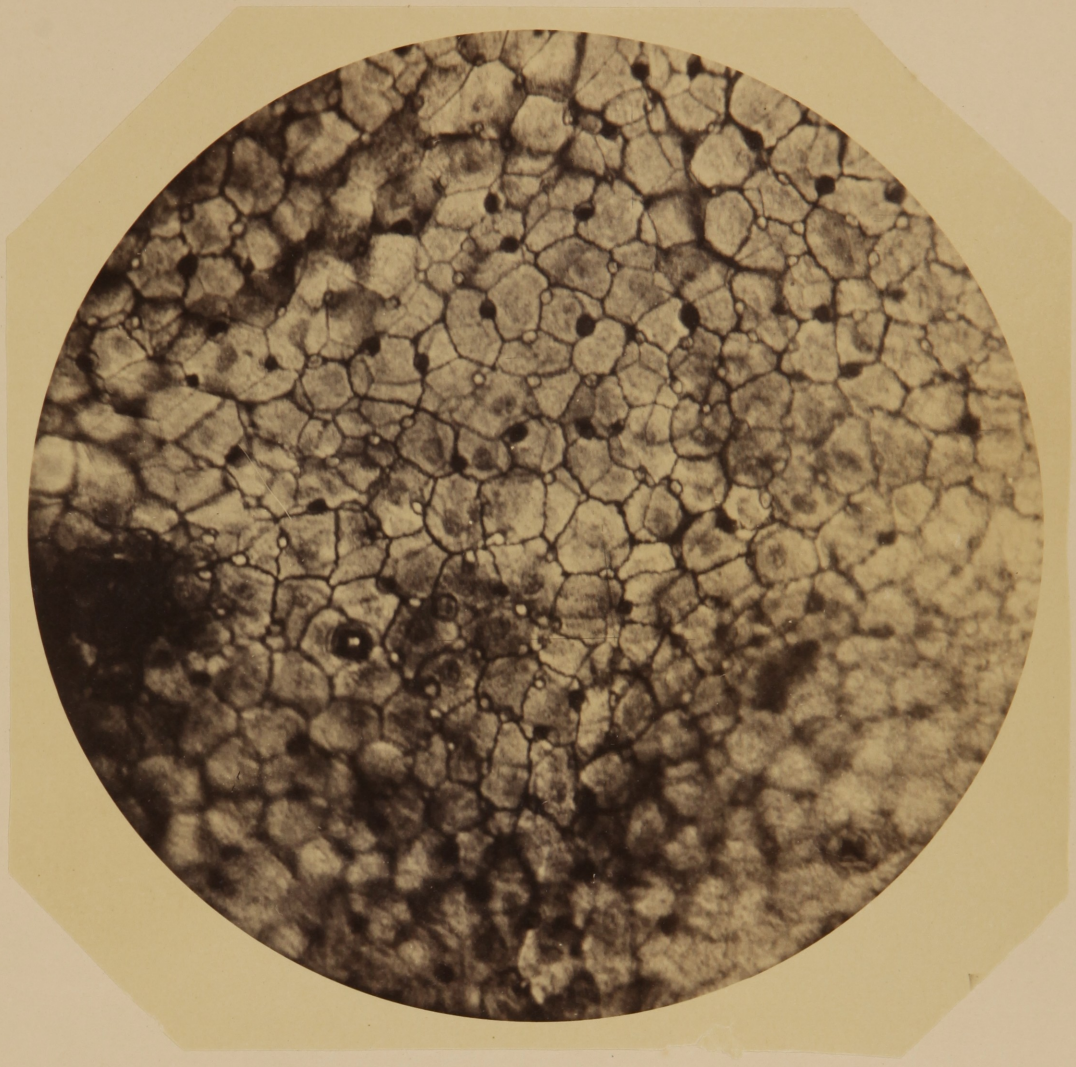
From the muscular coat of the Urinary bladder of the Frog.

The preparation copied, (No. 3378, Microscopical Section) had been injected with nitrate of silver, stained with carmine, and mounted in Canada balsam.

Magnified 1000 diameters by Powell & Lealand's immersion one-sixteenth objective.
Photo-Micrographic Negative No. 216. New Series.
Taken by the Calcium Light.

By Brevet Lieutenant Colonel J. J. WOODWARD, Asst. Surg., U. S. A.

By order of the Surgeon General.



WAR DEPARTMENT,

Surgeon General's Office, Army Medical Museum.

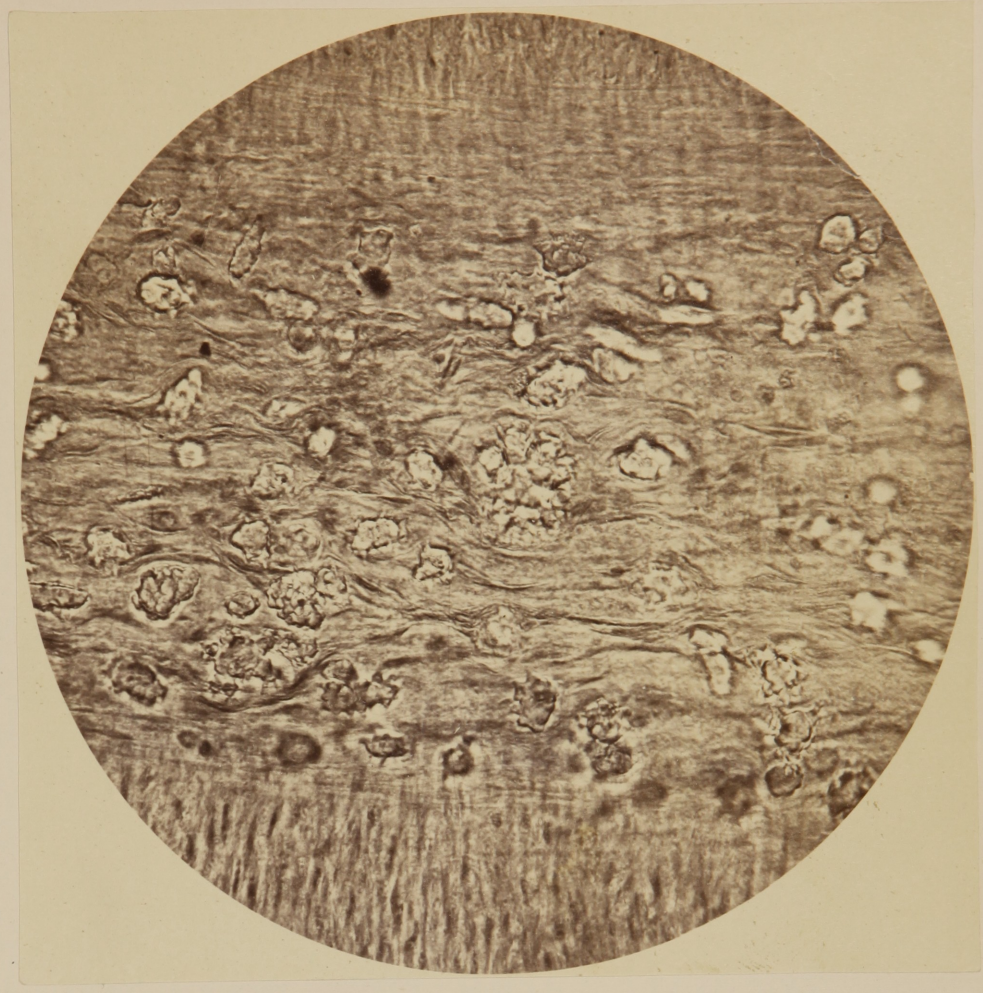
EPIDERMIS OF FROG, showing Stomata between the Epithelial cells.

The preparation copied, (No. 3036, Microscopical Section) had been stained with nitrate of silver, and mounted in Canada balsam.

Magnified 400 diameters by Wales' one-eighth objective.
Photo-Micrographic Negative No. 22. New Series.

By Brevet Lieutenant Colonel J. J. WOODWARD, Asst. Surg., U. S. A.

By order of the Surgeon General.



WAR DEPARTMENT,

Surgeon General's Office, Army Medical Museum.

WHITE BLOOD CORPUSCLES, exhibiting Amœboid movements in the external coat of a small vein.

From the inflamed stomach of a mare.

The preparation copied, (No. 3382, Microscopical Section) had been stained with carmine, and mounted in Canada balsam.

Magnified 400 diameters by Wales' one-eighth objective.
Photo-Micrographic Negative No. 46. New Series.

By Brevet Lieutenant Colonel J. J. WOODWARD, Asst. Surg., U. S. A.

By order of the Surgeon General.